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Pre-extension and demonstration of drainage technology for black cumin on Vertisols area of Abeshige district, Ethiopia

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Abstract: Pre-extension and demonstration of drainage technology (broad bed and furrow) with farmers' practice for black cumin (Nigella sativa) on Vertisols was carried out in Abeshige district of Gurage Zone, during 2020 and 2021cropping season. The main objective of the study was to create awareness on the availability and importance of black cumin on vertisols and to create awareness on the importance, knowledge and skill of drainage technology usage for production of the black cumin. The demonstration was undertaken on ten farmers' field with plot sized of 10m x 10m for each practice using recommended seed and fertilizer rates. The result showed that, drainage practice performed better (795 kg/ha) than farmers' practice (510 kg/ha). The yield advantage of the drainage technology over farmer practice was 55.8%. 'In addition to yield advantage, all participant farmers have selected the drainage technology. Thus, it is important to proceed to scaling up/out of the technology in all demonstration sites and similar agro-ecologies and soil type elsewhere.
Keywords: BBF, Farmers' preference, Waterlogging, Selection criteria

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INTRODUCTION

In Ethiopia, Vertisols account for 12.6 million hectares, of which about 7.6 million ha found in the highlands and are generally waterlogged due to abundant rainfall during the growing period (Tadesse and Haile, 2016). Ethiopia ranks third in Vertisols abundance in Africa after the Sudan and Chad. An estimated 7.6 million ha of Ethiopian Vertisols are located in the highlands above 1500 m.a.s.l. and on higher elevations (> 2500 m.a.s.l.) in temperate ecosystems (Lakew *et al.* 2005; Teklu *et al*. 2006). The highlands cover 40% of the total landmass of the country but account for about 95% of all cultivated land. Hence, the importance of Vertisols in the country is unquestionable.

Potentially, Vertisols are productive soils, but they are not easy to cultivate due to their poor internal drainage and resultant flooding and water logging during the wet season which contribute for lower crop yield. About 2 million hectares of highland Vertisols are currently being cropped. This means presently only 25% of the 7.6 million hectares Vertisols in the highlands are cultivated (Rutherford et al. 2001).

Black cumin grows on a wide range of soils. Sandy loam soil rich in microbial activity is the most suitable for its cultivation. The sloppy soils of heavy rainfall areas and levelled and well drained soils of moderate rainfall areas are quite suitable for its cultivation. Soil pH of 7.0 to 7.5 is favourable for production of black cumin (Ermias et.al as cited in Orgut, 2007) Nigella sativa has been used as a food preservative and to enhance flavour in many countries of the world for thousands of years and has also been used as a spice, and Nigella sativa seed and oil has been consumed for the treatment of many diseases in the world for many years. Today, it is believed to have antihypertensive, antihyperlipidemic, antidiabetic, and anticancer, antioxidant, antimicrobial, antitumor, antibacterial, and anti-inflammatory and immune-system effects through its components (Merve and Nevin, 2017). Nigella sativa is used to decrease asthenia and depression, and to increase body resistance (Razavi & Hosseinzadeh, 2014).

Due to high economic importance today the price of 100 kg of black cumin is 40,000 Ethiopian Birr. Even though it has high economic importance throughout the country yield and yield components of black cumin is decreased on Vertisols due to water logging problem. Therefore, draining out excess water through providing optimum drainage facilities is the way out to increase the production of black cumin on Vertisols. Keeping these in view the overall objective of this study was to create awareness on the importance, knowledge and skill of drainage technology usage for production of the black cumin at Abeshige district.

2. MATERIALS AND METHODS

2.1. Description of the study area

The demonstration was conducted on ten farmers' field in Abeshige district of Gurage Zone. Abeshige district is one of the rural district of Central Ethiopia Region which is located about 155 km away south of Addis Abeba along with the Addis Abeba to Jimma paved road. The district is bounded in north, south and west by Oromia Region and in the east by Cheha and Kebenadistrict.The absolute location of study area Extended 8º27'30" N to $38^0$10'50'' E (Fig 1).

The different relief features of the study area are the result of geological episodes of the tertiary period and the subsequent geomorphic processes. The climate of Abeshige district ranges from cool to warm. The annual average temperature of the area is 21.25^{0}C. The annual average rainfall is range from 801mm up to 1400 mm within the last ten years. The dominant soil type of the study area is fine to medium textured, sandy loam underlie with ancient Precambrian basement rocks in the plains and Calcoreous soil at the hills.

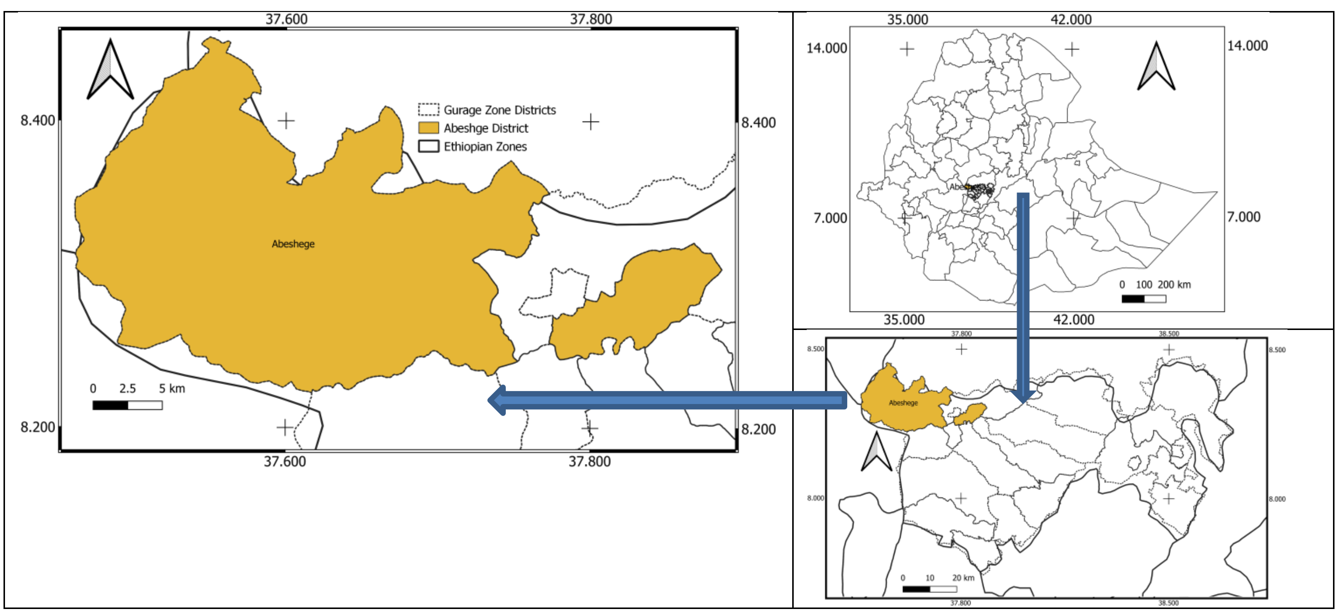

Figure 1: Map of study sites and district

2.1.2. Site selection

Pre-extension and demonstration of drainage technology for black cumin was carried out at Abeshige district. Purposive sampling method was employed to select two representative kebeles based on their potential for black cumin production and accessibility to road. A total of five farmers were selected purposefully based on accessibility and willingness.

Table1: Geographical location of the trial site

F.N	Plot size (m^2)	District	Kebele	Zone	Latitude	longitude	Altitude
F1	100+100	Abeshige	Abuko	Guraghe	8.336925	37.68100	1658
F2	100+100	Abeshige	Lache	Guraghe	8.312952	37.68100	1707
F3	100+100	Abeshige	Abuko	Guraghe	8.344441	37.66862	1657
F4	100+100	Abeshige	Lache	Guraghe	8.313942	37.69492	1705
F5	100+100	Abeshige	Lache	Guraghe	8.300731	37.69660	1715

3. Experimental design and management

Two treatments (T1 = farmer practice without drainage, T2 =BBF= 40 cm furrow and 80 cm bed drainage technology) were used side by side on adjacent plots with a plot size of 100 m^2 with 1m distance between plots at each experimental sites. Black cumin variety (Dirshay) and management technology BBF was demonstrated and compared with farmers practice. All the recommended agronomic management practices were carried out equally. The first weeding was done two week after planting and the second weeding carried out one month later after of the first weeding. Hosting farmers provided their land. Drainage preparations were carried out by the center where as land leveling, planting, first and second weeding, follow up visit, harvesting, threshing were handled and managed by the trial/hosting farmers . Blended fertilizer in the form of NPS (19% N, 38% $P_2O_5$and 7% S) was used as a source of N, P and S fertilizer. GPS was used during composite soil sampling for recording geographical taking coordinates of the sampling location**.**

3.1. Data collection

Data were collected using direct field observation/measurements, key informant interview and focused group discussion (FGD). Demonstration plots in all locations were harvested and yield data was recorded. Farmers‟ preference to the demonstrated technologies was identifie

3.1.2. Data analysis

Simple matrix ranking was used to compare traits of demonstrated technologies. Ranking scale was used to evaluate and select best technology and to rank their criteria according to real situation of the area. Yield advantage gain were calculated using the following formula below (Eq. 1).

$$Yield\ advantage\ \% = \frac{yeild\ of\ new\ technology - yeild\ of\ standard\ check}{yeild\ of\ standard\ check} \ldots\ldots\ldots\ldots\ldots (1)$$

4. RESULTS AND DISCUSSIONS

4.1. Mini field day feedback

During mini- field days as well as farm visit, different questions, opinions and suggestion were raised from farmers and reflected by the researchers. Most farmers showed high interest towards improved drainage technology due to better grain yield as compare to the Farmer practice. Generally, all farmers were very interested to have the technology for their future production but they raise the problem of labour for drainage preparation which was designed manual. Therefore, all concerned bodies must share their responsibility for the future machinery drainage technology introduction for drainage preparation.

Table 2: Professions and number of stakeholders participated on mini field day

Number	Participants	Male	Female	Total
1	Farmers	60	27	87
2	DA's	2	1	3
3	Researchers	3		3
	Total	65	28	93

4.2. Yield performance of the demonstrated technology

The yield obtained from the demonstration sites revealed that the mean yield of drainage technology (BBF) and farmers' practice was 786 kg ha^{-1} and 542 kg ha^{-1}, respectively in 2020 cropping year. In 2021, the mean yield of drainage technology (BBF) and farmers' practice was 804.4 kg ha^{-1} and 480 kg ha^{-1}, respectively. The overall two years mean yield of drainage technology (BBF) and farmers' practice was 795.2 kg ha^{-1} and 511 kg ha^{-1}, respectively (Table 3).

Table 3: Grain yield of drainage (BBF) and farmers 'practice and yield advantage in 2020 and 2021

Year	Treatment	Grain yield (kg/ha) across farmers					
		F1	F2	F3	F4	F5	Mean
2020	Drainage (BBF)	830	750	700	850	800	786
	Farmer practice	720	400	610	500	480	542
	Yield difference (kg/ha)	110	350	90	350	320	244
	Yield advantage (%)	15.28	87.50	14.75	70.00	66.67	45.02
2021	Drainage	970	652	800	825	775	804.4
	Farmer practice	700	430	370	300	600	480
	Yield difference (kg/ha)	270	222	430	525	175	324.4
	Yield advantage (%)	38.57	51.63	116.22	175.00	29.17	67.58
Average	Yield difference (kg/ha)	190	286	260	437.5	247.5	284.2
	Yield advantage (%)	26.92	69.56	65.49	122.50	47.92	56.30

4.3. Yield Advantage

The result indicated that the drainage technology had yield advantage of 45.02% and 67.58 % over the farmers practice in 2020 and 2021 cropping year, respectively. The two years average result indicated that the drainage technology had yield advantage of 56.3% over the farmers practice (Table 3).

4.4. Economic evaluation

The cost-benefit estimation result showed that Drainage BBF practice had higher benefit to cost ratio than the farmers practice (Table 4). One unit investment/cost in the production of black cumin using the drainage technology could yield 6.32 fold returns/benefit.

Table 4: Cost benefit ratio of drainage and farmer practice

Variables	Drainage (BBF)	Farmer practice
Yield obtained (kg/ha)	795.2	511
Sale price (ETB/kg)	300	300
Gross returns (TR)	238560	153300
Drainage and land preparation	10000	3000
Seed purchase	2000	3750
Fertilizers purchase (NPS)	2890	3650
Fertilizers purchase (UREA)	2800	3400
Weeding cost	4000	4000
Insecticide purchase	900	900
Harvesting & threshing	10000	10000
Total variable costs (TVC)	32590	28700
Net return (GR-TC)	205970	124600
Cost benefit ratio (NR/TVC)	1:6.32	1:4.34

4.5. **Farmers'' opinion/perception**

Farmers' in the study area had selected the best technology using their own criteria. Farmers set these criteria after having know-how about the technology. The opinion of participant farmers on technology preference was collected. The major criteria used by farmers were pod/plant number, pod height, seed size, stem strength; root has got soil, unproductive plants unavailability, plant height. Based on the above criteria's; farmers evaluated the technology and preferred drainage technology (BBF) then traditional practice due to higher number of pod/plant, height of pod, bigger seed size, better stem strength, Unavailability of unproductive plants and good plant height.

Table 5: Rank of the technologies based on farmers' selection criteria

Number	Practice	Rank	Reason
1	Drainage technology	1	Higher number of capsule/plant, height of capsule, bigger size of seed, better stem strength, root has got soil, unavailability of unproductive plants, good plant height
2	Farmer practices	2	Lower number of capsule/plant, smaller height of capsule, smaller size of seed, stem strength is not good, root hasn't got soil, availability of unproductive plant, plant height is not good

5. CONCLUSION AND RECOMMENDATION

Generally, through this participatory evaluation and demonstration process, many farmers became aware about the importance of drainage technologies as compared to farmer practice. The demands for the technology were also created. Demonstration result showed that drainage technology recorded high yielder than farmer practice at all location. It was also preferred by participant farmers for its better agronomic performance. Based on these facts, drainage technology (BBF) was recommended for further scale up and scale out for all demonstration sites and similar agro-ecologies and soil type elsewhere. We also recommend that further demonstration of different drainage technologies that easy the efforts of the farmers.

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